376-272

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COMMISS ENERGIE ATOMIQUE *EP -253-730-A
17.07.86-FR-010409 *(20.01.88)* G21c-19/06 G21f-09/34
Storage container with shafts for heat generating material - sized to allow convective flow of coolant in layers spaced from container wall
C88-007000 R(BE CH DE GB IT LI SE)

K(5-B7B, 7-A2)

A storage container for dry heat generating material has shafts for the material sized so that coolant fluid flows by convection in a layer along the wall of each shaft spaced from the walls of the container and the layers in adjacent shafts, an inlet for coolant in the lower wall of the container, and a coolant outlet in the upper wall.

USE

For storing spent fuel or other radioactive waste, esp. non-standard nuclear fuel e.g. from an experimental reactor.

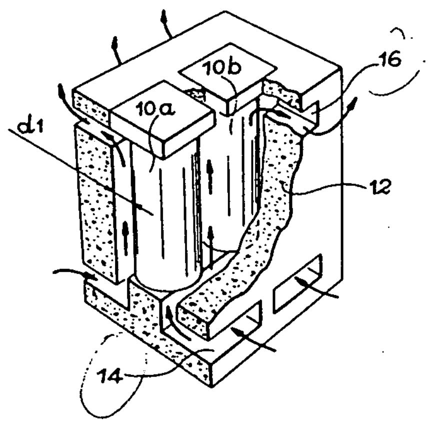
ADVANTAGE

Heat is effectively removed without forced cooling.

EMBODIMENT

Cylindrical metal shafts (10a, 10b) containing radioactive waste rest on sills in a concrete containment (12). The containment has apertures (14, 16) in its base and upper end for air which flows over the shafts by convection to cool them. The distance (d1) between each shaft and the walls of the containment is sufficiently large for the layer of air flowing along the shaft not to contact the walls. (14pp1658RKMHDwgNo 3/9).
(F)ISR: GB2046162 FR2502829 DE1711405 DE2730729.

EP-253730-A+



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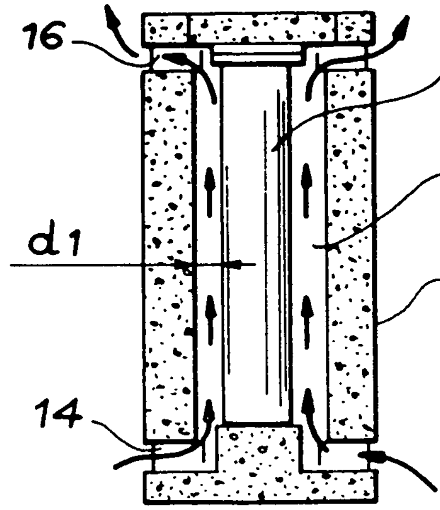

FIG. 1

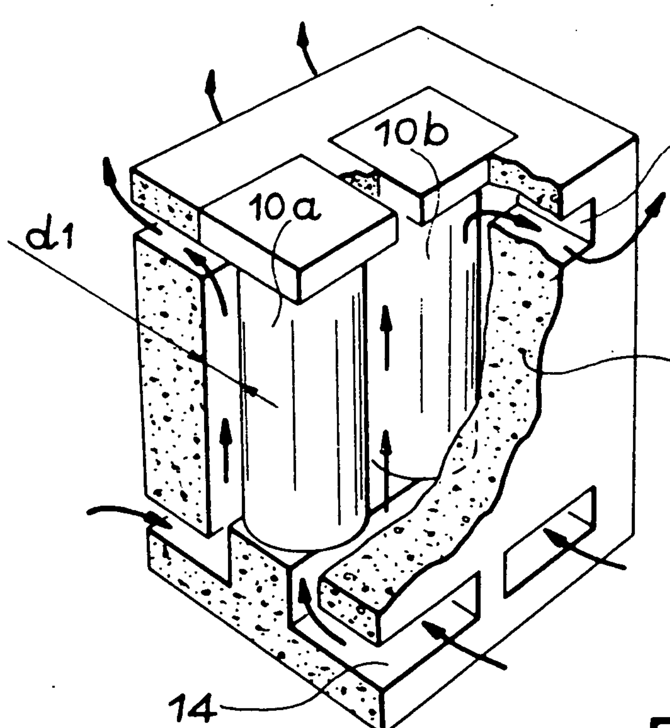

FIG. 3

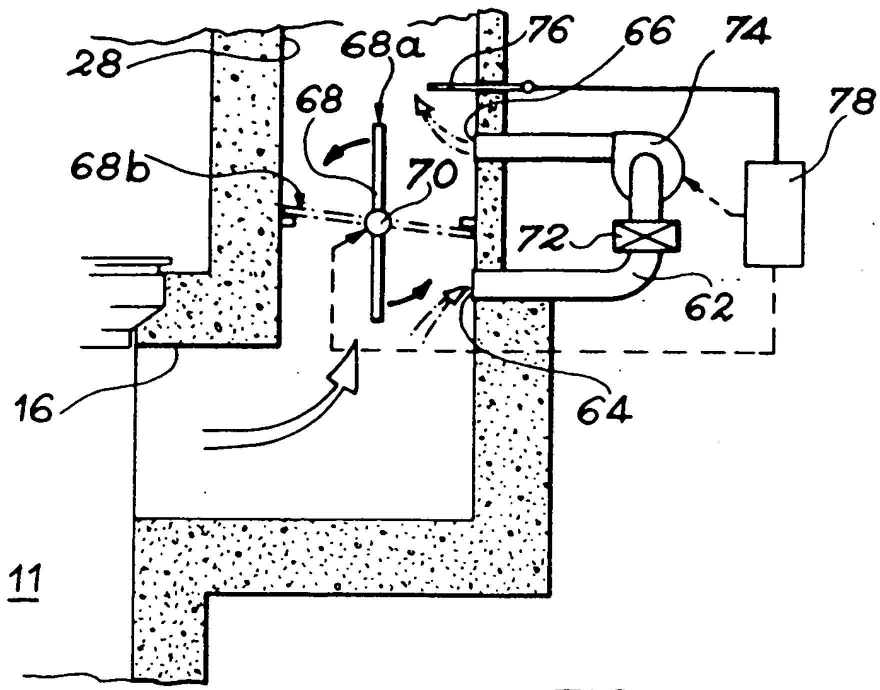

FIG. 7

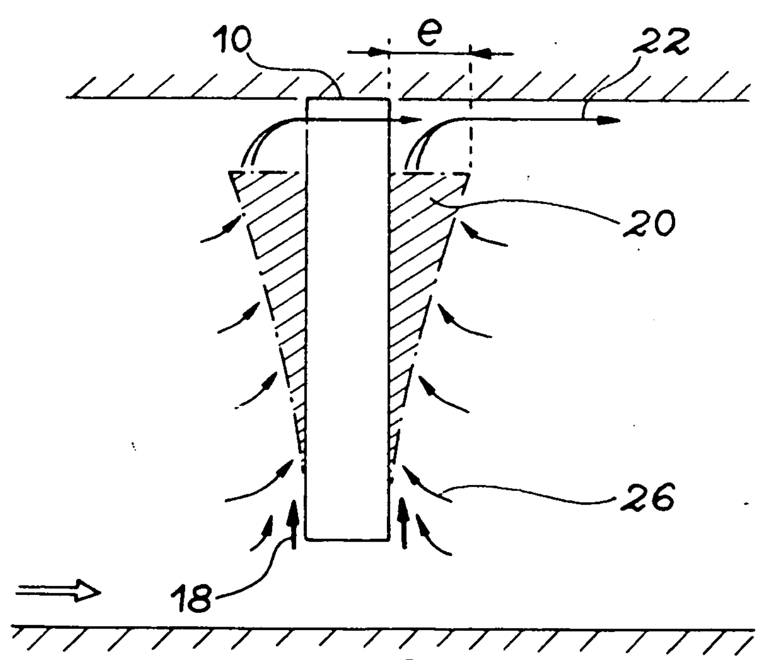

FIG. 2

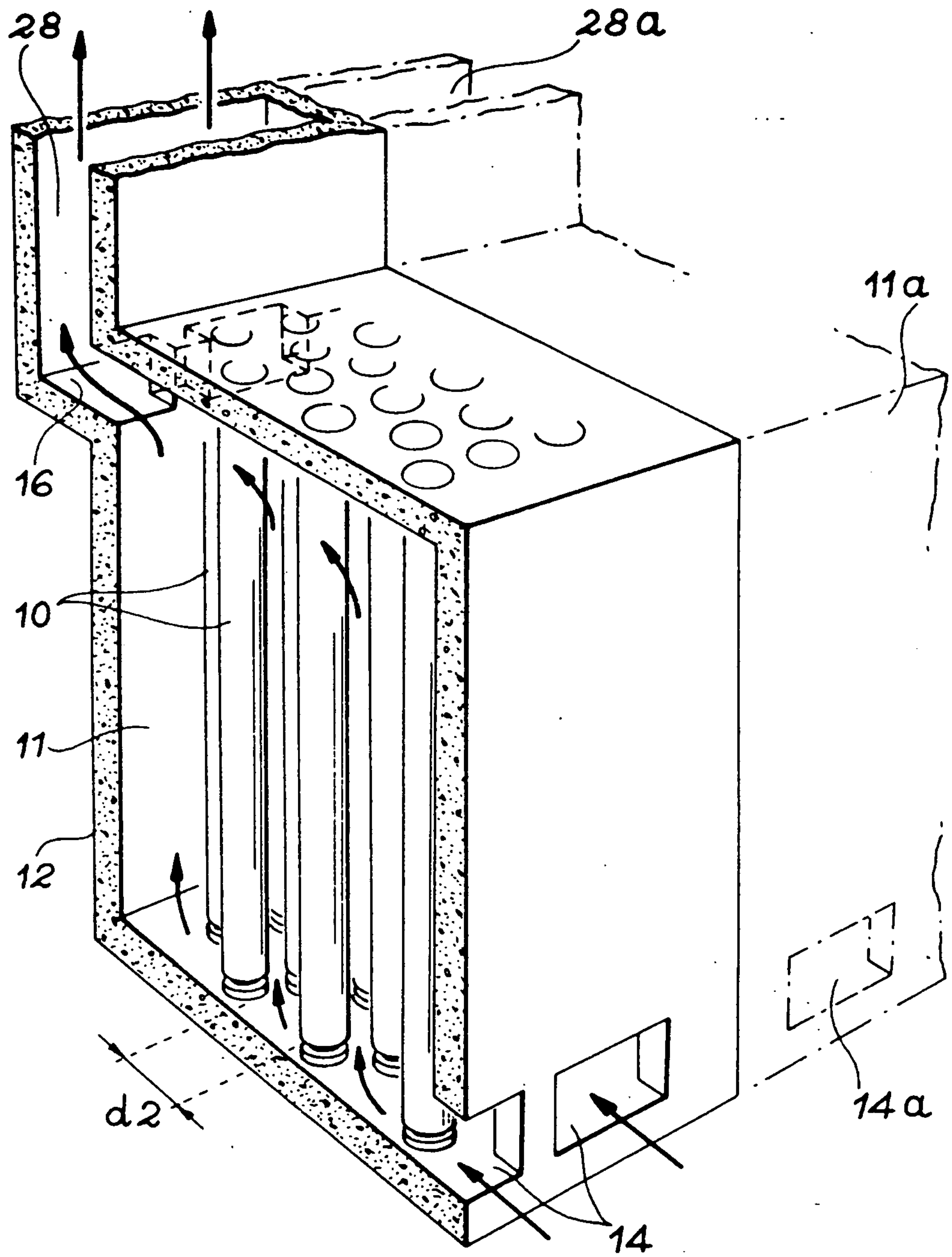

FIG. 4

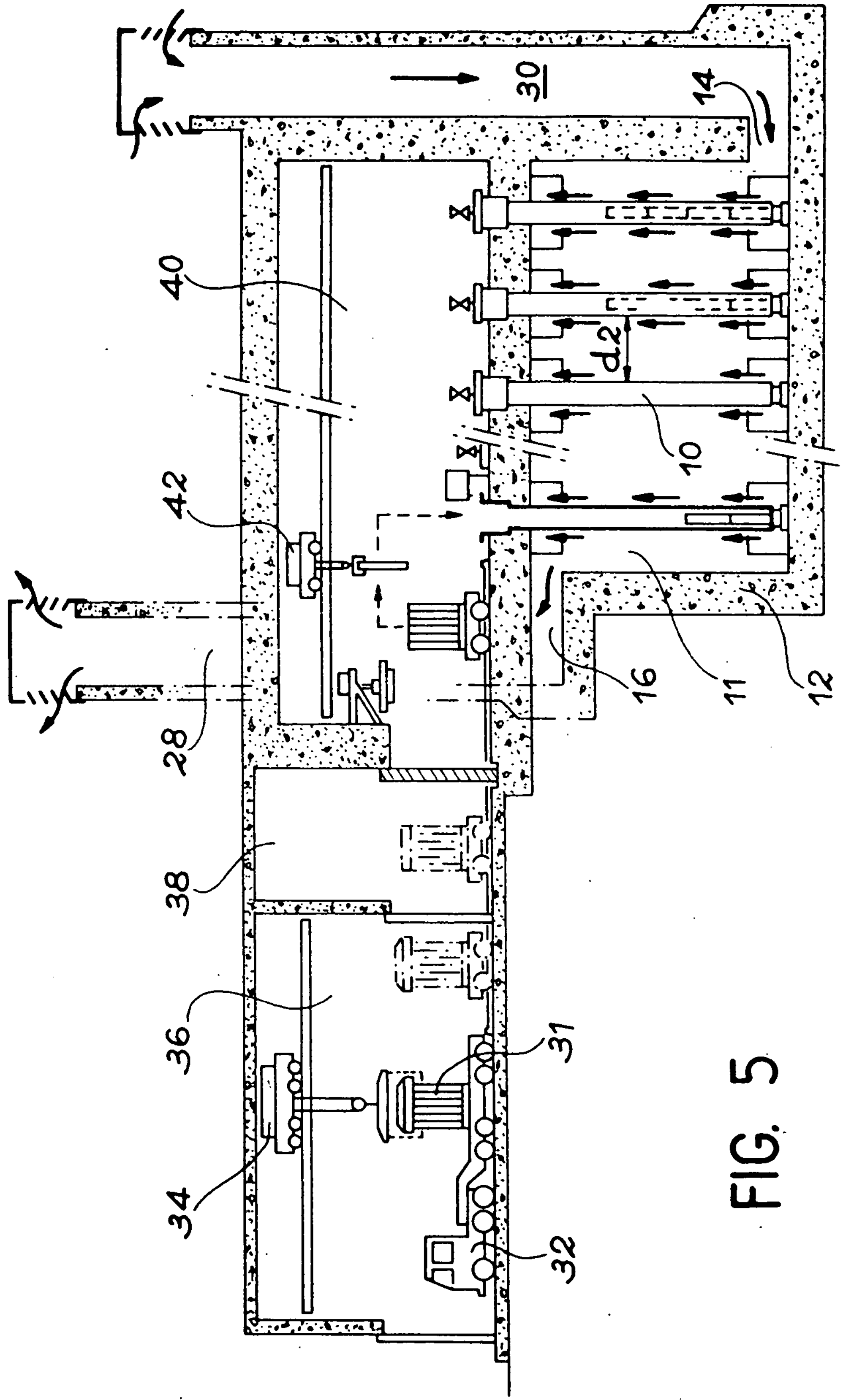

FIG. 5

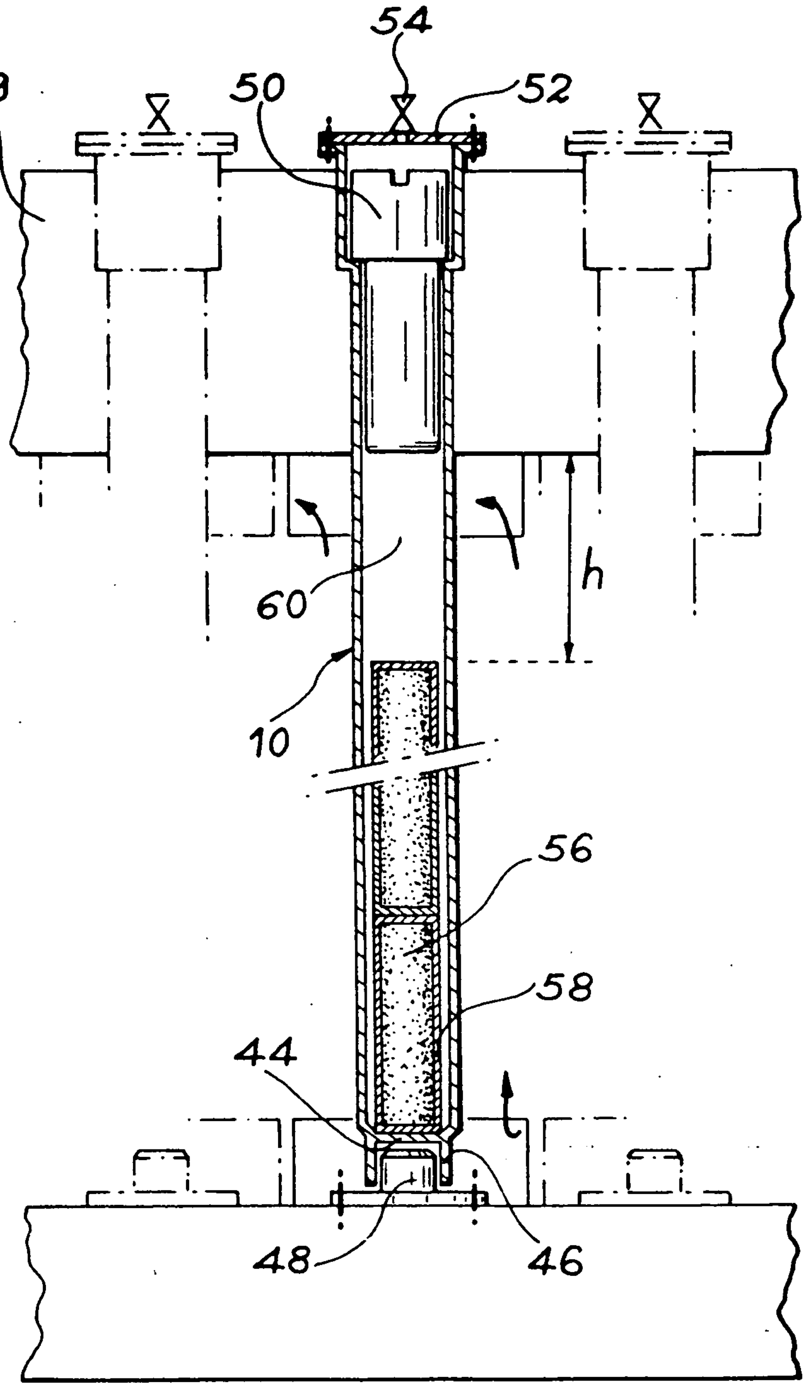

FIG. 6

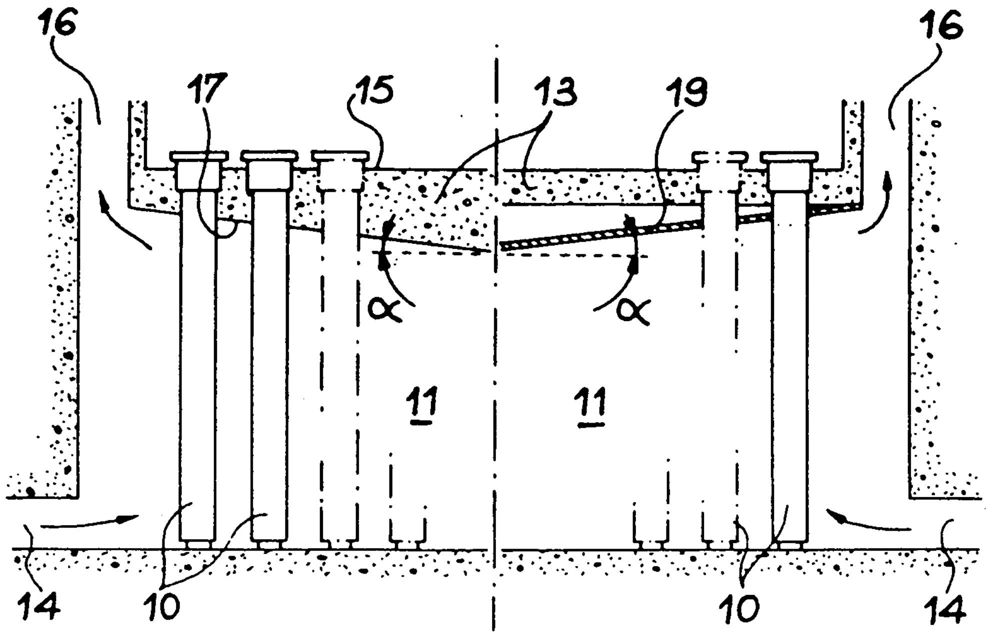

FIG. 8

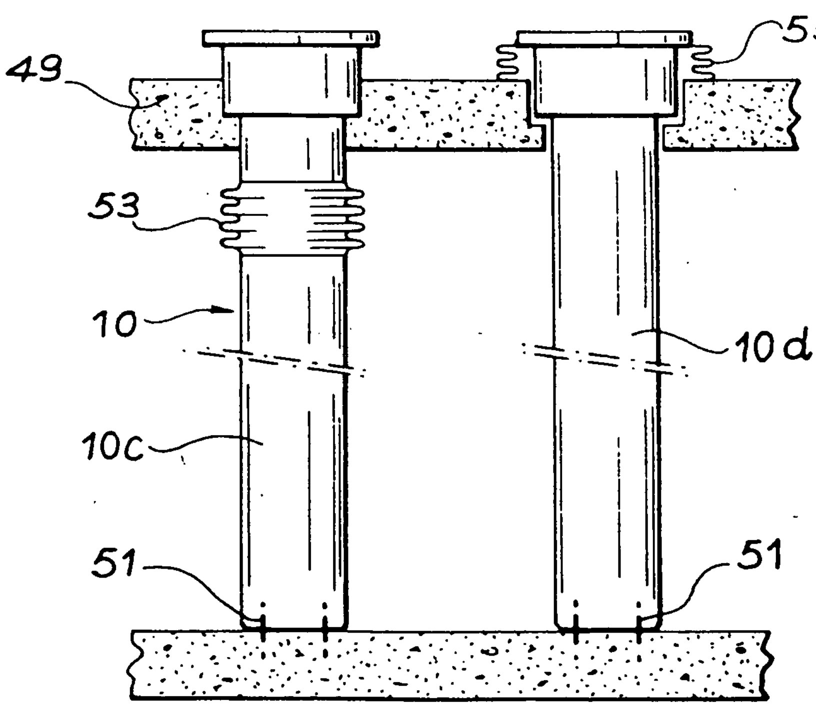

FIG. 9

PTO 03-1911

CY=DE DATE=19861106 KIND=A1
PN=3 515 871

TRANSLATION

=> 376/272.

TRANSPORT AND STORAGE CONTAINER FOR FUEL ELEMENTS
[Transport- und Lagerbehälter für Brennelemente]

G. Becker, et al.

UNITED STATES PATENT AND TRADEMARK OFFICE
Washington, D.C. March 2003

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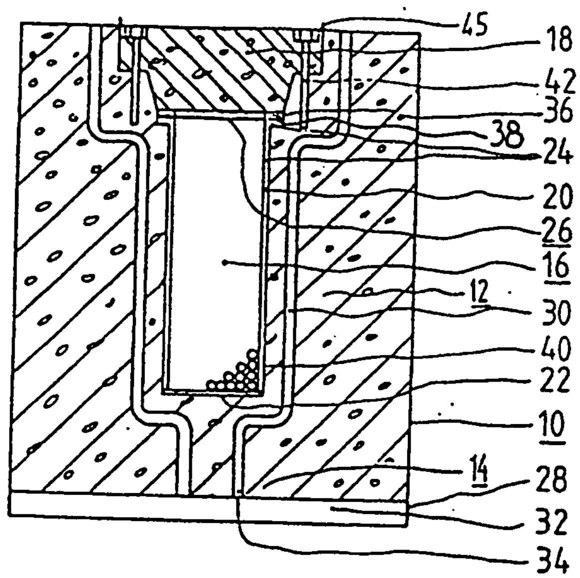
TITLE	(54):	TRANSPORT AND STORAGE CONTAINER FOR FUEL ELEMENTS
FOREIGN TITLE	[54A]:	Transport- und Lagerbehälter für Brennelemente

(54) /0*

The invention relates to a device for transporting and storing fuel elements for nuclear reactors. It is a closed container **10, 11** of steel-reinforced concrete whose interior **16, 17** is designed to accommodate spherical fuel elements **47** and whose outer contour is cuboid or cylindrical.



Claims /1

1. A device for transporting and storing fuel elements for nuclear reactors, especially for gas-cooled high-temperature reactors, characterized in that the device is a compact, sealable container **10, 11** of steel-reinforced concrete, whose interior **16, 17** is designed to accommodate spherical fuel elements **40** and whose wall thickness is sufficient for shielding radioactive radiation.

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* Numbers in the margin indicate pagination in the foreign text.

2. A device as recited in Claim 1, characterized in that the reinforcement **47** of container **10, 11** is spatially arranged over the cross section of the wall.

3. A device as recited in Claim 1, characterized in that container **10, 11** has a removable cap **18, 19**.

4. A device as recited in Claim 1, characterized in that container **10, 11** is cuboid in shape.

5. A device as recited in Claim 1, characterized in that container **10, 11** is cylindrical in shape.

6. A device as recited in one of the previous Claims, characterized in that container **10, 11** has an interior **16, 17** /2 whose shape corresponds to the outer contour of container **10, 11**.

7. A device as recited in one of the previous Claims, characterized in that interior **16, 17** of container **10, 11** accommodates a metallic inner container **24, 25**.

8. A device as recited in one of the previous Claims, characterized in that metallic inner container **24, 25** is made of cast material.

9. A device as recited in one of the previous Claims, characterized in that metallic inner container **24, 25** is welded of sheet steel, which lines interior **16, 17** in the form of a liner.

10. A device as recited in one of the previous Claims, characterized in that cap **18, 19** is inserted into the container, lying flush with its surface and sealing it.

11. A device as recited in one of the previous Claims, characterized in that the cap is inserted into the container in a stepped manner.

12. A device as recited in one of the previous Claims, characterized in that the inside of cap **18, 19** is shaped corresponding to the bottom **22, 23** of interior **16, 17**.

13. A device as recited in one of the previous Claims, /3
characterized in that holding means **42, 43** are porvided for holding down cap **18, 19**.

14. A device as recited in one of the previous Claims, characterized in that mooring screws or prestressing elements, anchored in container walls **12, 13** are used as the holding means.

15. A device as recited in one of the previous Claims, characterized in that holding means **42, 43** are removable.

16. A device as recited in one of the previous Claims, characterized in that the joint between cap and container is sealed gas tight.

17. A device as recited in one of the previous Claims, characterized in that sealing elements are arranged in joint **36, 37** between cap **18, 19** and container **10, 11**.

18. A device as recited in one of the previous Claims, characterized in that O-rings of plastic and/or metal are provided as sealing elements **38, 39**.

19. A device as recited in one of the previous Claims, characterized in that the inside of cap **18, 19** is provided with a metallic liner **24, 25**.

20. A device as recited in one of the previous Claims, /4 characterized in that container wall **12, 13** is made of concrete that possesses high strength, even at high temperatures.

21. A device as recited in one of the previous Claims, characterized in that container **10, 11** is made of heavy concrete for better heat conduction.

22. A device as recited in one of the previous Claims, characterized in that reinforcement **47** is made of prestressing steel.

23. A device as recited in one of the previous Claims, characterized in that interior **16, 17** of container **10, 11** is provided with an impact resistant thermal insulation.

24. A device as recited in one of the previous Claims, characterized in that the outer surface of the container has a decontamination-friendly coating.

25. A device as recited in one of the previous Claims, characterized in that the outer surface of the container is lined with sheet steel for decontamination.

26. A device as recited in one of the previous Claims, characterized in that cool air-carrying cooling channels **30, 31** are provided for cooling interior **16, 17**.

27. A device as recited in one of the previous Claims, /5 characterized in that cooling channels **30, 31** are guided through the concrete structure of container **10, 11** at a short distance from interior **16, 17**.

28. A device as recited in one of the previous Claims, characterized in that cooling channels **30, 31** are arranged axially and radially.

29. A device as recited in one of the previous Claims, characterized in that cooling channels **30, 31** rise obliquely.

30. A device as recited in one of the previous Claims, characterized in that cooling channels **30, 31** rise helically.

31. A device as recited in one of the previous Claims, characterized in that joint **36, 37** between cap **18, 19** and container **10, 11** is sealed on its outer surface by means of a welded lip seal.

32. A device as recited in one of the previous Claims, characterized in that container wall **12, 13** is made of steel-fiber-interspersed concrete that possesses high strength, even at high temperatures.

The invention relates to a device for transporting and storing /6 spherical fuel elements for nuclear reactors, particularly for gas-cooled high-temperature reactors.

Like other radioactive materials, fuel elements for nuclear reactors must be securely shielded to protect the environment from radioactive contamination. This applies both to their transport and to their

storage. Fuel elements for liquid-cooled nuclear reactors frequently consist of thin-walled tubes having a diameter of 6 to 10 mm and a length of 3 to 4 m, in which the tablet-shaped, sintered nuclear fuel is sealed gas tight, in order to prevent reactions with the coolant and to retain gaseous fission products. The fuel elements are often used in the form of cassettes. These so-called fuel cassettes are bundels of at most 200 to 300 cylindrical fuel elements or fuel rods.

For gas-cooled high-temperature reactors, ceramic fuel elements /7 are used in which the fuel, in the form of small spheres measuring ca. 1 mm, which are coated with pyrolitic carbon, are distributed over a graphite matrix in rod, block, or spherical form.

For protection against radioactive radiation, it is known to use materials that reduce the danger by absorption or scattering of the radiation. Shielding is required when the radiation exposure cannot be reduced by sufficient distance from the source to prevent radiation damage. Heavy substances such as lead, lead glass for windows, or baryte concrete for walls are used for shielding from X-rays and gamma rays, since the effectiveness of measures against these types of radiation depends almost entirely on irradiated weight per unit volume. Hydrogen-containing or light substances are more favorable for shielding against neutrons since, with their high stopping power, they slow fast neutrons to lower energy levels in which the neutrons are scattered and absorbed to a greater degree. Thus, devices for storing

and transporting fuel elements for nuclear reactors should be created taking the above-mentioned considerations into account.

While transport and storage containers are previously known for fuel elements for liquid-cooled nuclear reactors, in the case of spherical fuel elements for gas-cooled high-temperature reactors, the task is to create a transport and storage container that is easy to produce and move and that takes into account the above-mentioned considerations. /8

The solution to this task is found in the characterizing part of Claim 1. For the transport and storage of spherical, radioactive fuel elements for nuclear reactors, it provides for a closed container of steel-reinforced or prestressed concrete whose steel reinforcement is spatially arranged over the cross section of the wall, i.e. the steel reinforcement runs axially, tangentially, and radially in the concrete. It is advantageous if the container is sealed with a removable cap that is inserted into the container, lying flush with its surface and sealing it and whose stepped edge matches the opening in the container. Like the container, the cap is provided with steel reinforcement. The inside of the container is sealed gas tight by prestressing elements distributed over the circumference of the cap and by a seal in the container opening. In order to prevent excessive heating of the concrete body, it is advantageous to provide cooling channels, evenly distributed in the container wall around its interior, through which a cooling agent, such as air, can flow,

cooling the container wall that is heated by the afterheat from the fuel elements.

In accordance with this invention, the container is made of concrete with high strength that is retained even at elevated temperatures. Steel fibers can be added to the concrete to improve its resistance to damage during transport.

Heavy concrete may be used to advantage to improve heat /9 conduction. It is advantageous if the exterior contour of the container is cuboid, although it may also be cylindrical. The interior of the container has an inner liner that is made of welded sheet steel or is a cast container, the shape of which corresponds to that of the outer contour of the container. However, it may be suitable, particularly when a cast container is used, to make the interior cavity cylindrical, regardless of the outer contour of the container, in which case the end surfaces of the hollow cylinder may be level or convex.

The cooling channels that are provided for better heat conduction are arranged to be rising axially or helically. For cooling the cap, the latter also has cooling channels, which connected to the channels in the container wall. The bottom contact area of the container is grooved, thereby permitting a flow of air to the cooling channels. The wall thickness of the container depends on the strength requirements and the necessary radiation protection. In accordance with this invention, the container is coated, for example, with sheet steel to

facilitate decontamination. O-rings of temperature-resistant plastic, with or without a metal core, or welded lip seals can be used as seals between container and cap. So that the container can also be used for fuel elements with high heat production, the invention provides for impact-resistant thermal insulation for the interior of the container.

These and other advantageous embodiments and improvements of the /10 invention may be found in the dependent claims.

With the help of the drawing, which shows one embodiment of the invention, the invention, advantageous embodiments, and improvements on the invention as well as additional advantages will be explained and described in greater detail.

The figures show:

Figure 1: a longitudinal section of a container with a rectangular design;

Figure 2: a longitudinal section of a container with a circular design;

Figure 3: top view of a container as in Fig. 1;

Figure 4: bottom view of a container as in Fig. 1[1)];

Figure 5: top view of a container as in Fig. 2;

Figure 6: bottom view of a container as in Fig. 2[1)];

Figure 7: partial cutaway view of the three-dimensional reinforced casing of a container as in Fig. 2.

[1)]The crosshatched surfaces indicate the raised surfaces.

Figure 1 shows a cuboid container **10** whose side walls **12** and bottom **14** are made of concrete with three-dimensional reinforcing steel. Interior **16**, which is open on one end, is sealed with cap **18**. Like the container, interior **16** is cuboid in shape. Its walls **20** and bottom **22** are lined with a liner **24** of cast steel or welded sheet /11 steel. Cap **18**, which like the container bottom is also made of steel-reinforced concrete, is also provided with a liner **24** on its inside. Cap **18**, which is inserted into container **10**, has at its periphery step-like structures, which match the corresponding recesses in container opening **26**. To provide cooling by air circulation, cooling channels **30** pass close to internal wall **20** and internal bottom **22**. To allow air to enter cooling channels **30** bottom **14** of container **10** is provided with ribs **32**, which run parallel to the side edge, forming cooling ducts **28** between them, through which air from outside can flow to reach opening **34** of cooling channels **30**.

In joint **36** between container **10** and cap **18** there are sealing elements **38** that seal interior **16** against the outside atmosphere and prevent dusty or gaseous contaminants produced by fuel elements **40** in interior **16** from reaching the outside. Cap **18** is held down by tie rods **42**, which are uniformly distributed around its periphery. This compresses sealing elements **38**, increasing the sealing effect.

Figure 2 shows a cylindrical container **11** whose side wall **13** and bottom **15** are made of steel-reinforced concrete with three-dimensional

reinforcement, as in container **10** in Figure 1. The likewise cylindrical interior **17** in the middle of container **11** has an outwardly arched bottom **23** which, like interior wall **21**, is lined /12 with a liner **25** of cast steel or welded sheet steel. Opening **27** of interior **17** is sealed by cap **19**, which is inserted into container **11** and which has at its periphery step-like structures, which match the corresponding recesses in container opening **27**.

In order to cool the container, cooling channels **31**, which pass from bottom **15** of container **11** upward and pass through cap **19**, are uniformly distributed about the periphery, close to interior **17**. In order to seal interior **17** of container **11** against the exterior atmosphere, sealing elements **39**, in the form of plastic or metal O-rings, are located in joint **37** between container wall **13** and cap **19**. Cap **19** is held down by means of tie rods **43**, which are uniformly arranged around its periphery. Sealing elements **39** are compressed by the force, thereby increasing the sealing effect. To allow air into cooling channels **30** on bottom **15** of container **11**, radial ribs **33** are provided, between which slits **29** are provided, through which the air gains access to cooling channels **31**.

Figure 3 shows the top of a container **10**, a longitudinal section of which is shown in Fig. 1. Like the design of container **10**, cap **18** has a rectangular outer contour. At equal distances from joint **36**, shown as a line, there are tie rods **42** in cap **18** and in wall **12** there are cooling channels **30**.

/13

Figure 4 shows a top view of bottom **14** of container **10**. As explained above with reference to Fig. 1, bottom **14** is provided with ribs **32**, which form ducts **28** between them. Placing container **10** on a level bottom in this way assures that sufficient cooling air can pass through ducts **28** to openings **34** of cooling channels **30**.

Figure 5 shows a top view of container **11**, the longitudinal section of which was previously shown in Fig. 2. As already explained with reference to Fig. 2, container **11** has a circular cross section. Its cap **19**, which also has a circular outer contour, has through-holes at its periphery for tie rods **43**. Concentric to these holes, however, outlet openings **45** for cooling channels **31** are arranged in a circle with a smaller radius.

Figure 6 shows a view of bottom **15** of container **11**, as shown in Fig. 2. Radially arranged ribs **33** form slits **29**, which run from the outside to the center and allow air to reach openings **35** at the end of slits **29** for cooling channels **31**.

Figure 7 shows a container **11** as seen in Fig. 2 with a partial cutaway view of its side wall **13**. This partial cutaway view reveals the arrangement of three-dimensional reinforcement **47**. Here, the reinforcement is not only in the vicinity of the surface, as usually is the case, but it is arranged in layers throughout the entire thickness of the wall. The individual layers of mesh reinforcement are connected together at nodes by transverse reinforcing rods, thus producing a three-dimensional rod structure.

Using a combination of concrete and three-dimensional /14 reinforcement, it is possible to safely meet the special requirements involved in the storage and transport of fuel elements, with regard to radioactive radiation and stresses caused by weight and/or pressure.

When implementing the invention, it is important to use concrete that possesses high strength, even at elevated temperatures. For better heat conduction, it may be suitable to use metal-containing heavy concrete. Instead of the simple three-dimensional reinforcement in the description of the figures, it may be suitable to use prestressing steel. The seal for the vessel that is inserted into it can be made of reinforced concrete or of cast steel or spheroidal graphite cast iron. Instead of tension rods, prestressing elements may be used to hold down the container cap. It may be favorable to provide a welded lip-type seal for sealing the joint between the container cap and the container wall. As seen in the longitudinal section through the container (Figs. 1 and 2), the cooling channels should be arranged as close as possible to the interior of the container. The changes in direction, e.g., zigzags, this necessitates must be taken into account when designing the cross sectional areas of the cooling channels. In addition to the axial-radial arrangement of cooling channels shown in the example, they may also rise
obliquely or helically. The outer surface of the container is /15 suitably made such that decontamination may be carried out without difficulty. This may be achieved by coating or lining it with sheet

steel. When fuel elements with a high heat production are being stored, it may be necessary to provide the interior with impact-resistant thermal insulation. The wall thickness of the container is basically determined by the strength requirements, as well as the required radiation protection.

Additional advantageous characteristics of the invention relate to the cooling channels and the space requirements of the container. Of course, in accordance with this invention the number and/or arrangement of the cooling channels may vary, depending on the cooling requirements, i.e., the heat buildup of the material in the container, and the economical production of the container, and may differ from the example shown. Moreover, replaceable feet, instead of ribs, may be integrated onto the bottom surface of the container. In this way, damaged feet can be replaced at any time or the container may be adapted to a specific transport system.

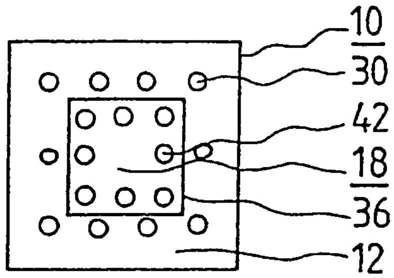

Fig.3

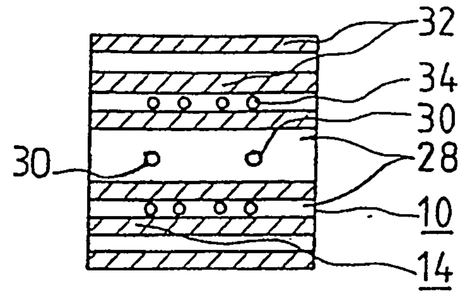

Fig.4

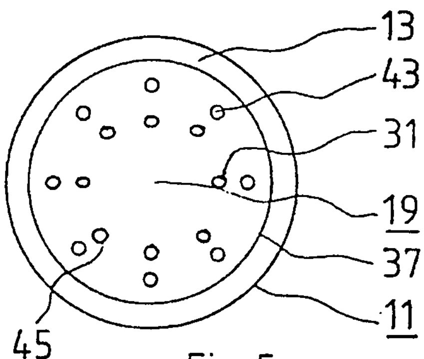

Fig.5

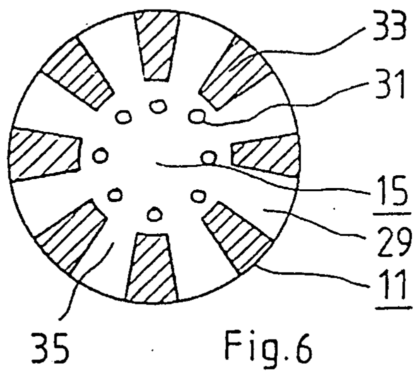

Fig.6

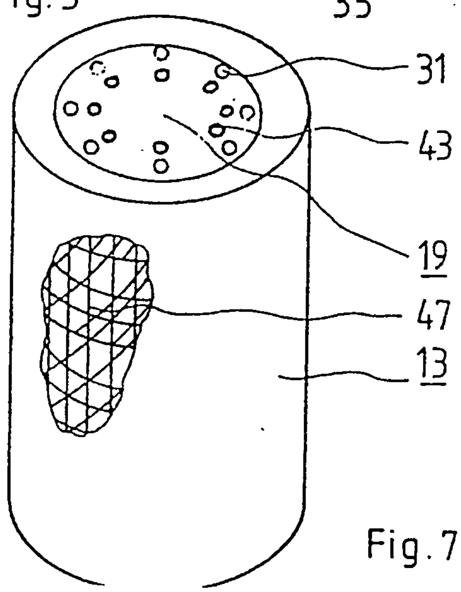

Fig.7

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TRANSLATION

PTO: 2003-746 ⇒ 376/272.

Japanese Published Unexamined (Kokai) Patent Application No. S62-185199, published August 13, 1987; Application No. S62-185199, filed August 13, 1987; Int. Cl.[4]: G21C 19/32 19/06; Inventor(s): Daiju Saito et al.; Assignee: Ishikawajima Harima Heavy Industry Corporation; Japanese Title: Haku you Genshiro no Nenryou Koukan you Kyasuku-rui no Hanshutsunyu Setsubi niokeru Kisuimitsu Shikiri Souchi (Air-water Tight Partitioning Device in a Transfer Facility for Marine Reactor Fuel Replacing Casks)

Specification

1. Title of Invention

Air-water Tight Partitioning Device in a Transfer Facility for Marine Reactor Fuel Replacing Casks

2. Claim

An air-water tight partitioning device in a transfer facility for marine reactor fuel replacing casks, characterized by being comprised of the following components: a sliding hatch cover endowed with an air-water tight function, which opens and closes an opening on the top of a reactor chamber; a larger diameter end attached to the circumference of the opening of the sliding hatch cover; cone-shaped flexible bellows formed so as to be invertible.

3. Detailed Description of the Invention

[Field of Industrial Application]

This invention pertains to air-water tight partitioning devices in transfer facilities for marine reactor casks that adopts flexible bellows so as to keep the air-water tight function when the fuel replacing casks are transferred into and out of storage containers with vessel

reactors stored.

[Prior Art]

Prior art fuel replacing facility for a nuclear ship is illustrated in Fig.4 and Fig.5. This fuel replacing facility comprises the following components: a deck working building d temporarily built on a deck c of a nuclear ship b inside a dry dock a; an electric door e that opens and closes an opening on the side wall of deck working building d by an air-water tight means; a ceiling crane g that transfers casks f inside deck working building d; a sliding hatch cover I that opens and closes an opening on the top of a reactor chamber h; a land crane j provided on the dock side. Reference numbers k and l refer to a storage container and a reactor container, respectively.

The steps to transfer casks f into storage container k are described as below. Electric door e of deck working building d is first opened. Using land crane j, casks f are once temporarily placed on deck c. Following this step, by closing electric door e, the opening on the side wall of deck working building d is sealed by an air-water tight means. After this step, by opening sliding hatch cover I, the opening on the top of reactor chamber h is opened. Casks f on deck c are transferred into storage container k by using ceiling crane g and then suspended on reactor container l. Reverse steps are taken for transferring casks f out of storage container k. As for this fuel replacing facility, either electric door e or sliding hatch cover I is closed in any transfer steps as described above. For this reason, the partition endowed with an air-water tight function between a radiated fuel and the environment is continuously maintained.

[Problem of Prior Art to Be Addressed]

However, the fuel replacing facility has the following disadvantages:

(1) This fuel replacing facility requires large ceiling crane g in deck working building d as a transporting means for casks f other than land crane j. Along with this requirement, the scales of deck working building d that needs to possess an air-tight function and electric door e increase. Furthermore, this type of systems that require large scale deck facilities is not practical due to disadvantages as follow. It takes a long period of time for the installation and the removal. It also involves a higher cost;

(2) Because radioactive substance containing air flows into deck working building d from reactor chamber h when hatch cover I on the top of reactor chamber h is opened, the amount of the radioactive substances flowed increases, and the interior of deck working building d becomes an insufficient environment for the workers.

[Objective of the Invention]

The present invention is produced so as to effectively eliminate the disadvantages of prior art devices and aims to offer an air-water tight partitioning device in a transfer facility for marine reactor fuel replacing casks that significantly reduces in the weight of and simplifies the transfer facility for the marine reactor casks and that can reduce the amount of radioactive substance containing air to flow in the environment.

[Abstract of the Invention]

In order to achieve the objective, the invention is comprised of the following

components: a sliding hatch cover endowed with an air-water tight function, which opens and closes an opening on the top of a reactor chamber; a larger diameter end attached to the circumference of the opening of the sliding hatch cover; cone-shaped flexible bellows formed so as to be invertible.

The reactor chamber is partitioned with at least one of the following components by an air-water tight means: the sliding hatch cover; the flexible bellows.

[Embodiment]

The embodiment of the invention is described hereinbelow in detail with reference to the drawings.

Fig.1 illustrates cask transfer facility of the invention, which is endowed with an air-water tight partitioning device. As shown in the drawing, a nuclear ship 2 is installed in a dry dock 1. A land crane 3 is provided on the dock side. A fuel handling building is built on land, as not shown in the drawing. A transfer platform 5 issued for carrying a fuel replacing cask 4 between the fuel handling building and dry dock 1.

As shown in Fig.1 to Fig.3, a storage container 7 is provided inside a rector chamber 6 of nuclear ship 2. A reactor container 8 is stored in storage container 7. A nuclear fuel 9 and a rotation blocking table 10 are installed in the reactor core of and on the top of reactor container 8, respectively. A sliding hatch cover 12 is attached to a hatch coaming 11 on the top of reactor chamber 6 by an air-water tight means. Sliding hatch cover 12 possesses a sliding hatch lid 13 that opens and closes the hatch opening. An opening-closing operational system (not shown in the drawing) is connected to sliding hatch lid 13. The air-water tight function

of sliding hatch lid 13 is maintained by a ring-shaped inflating seal 14 provided on the inner circumferential wall that encloses the opening of sliding hatch cover 12.

A larger diameter end flange 15a of cone-shaped flexible bellows 15 is attached around the hatch opening on sliding hatch cover 12 by an air-water tight means. Furthermore, a smaller diameter end flange 15b of flexible bellows 15 is attached to a ring-shaped disk 4a by an air-water tight means and so as to be attachable and detachable, which is extended from the outer circumferential wall surface of fuel replacing cask 4. Because bellows 15 is in the cone shape and has flexibility, it inverts by moving the smaller diameter end in the axial direction. A support cylinder 16 is provided on sliding hatch cover 12 in a standing position, which supports flexible bellows 15. A suspension type holding arm 17 is provided to support cylinder 16. Holding arm 17 supports the smaller diameter end of flexible bellows 15 and does not allow the total weight of fuel replacing cask 4 to be transmitted to sliding hatch cover 12 even if fuel replacing cask 4 vertically moves while attaching or detaching disk 4a of fuel replacing cask 4 and smaller diameter end flange 15b.

A transfer work for fuel replacing cask 4 into storage container 7 is described next.

Loaded fuel replacing cask 4 on transfer platform 5 on the dock side is transported onto the nuclear ship side by land crane 3 and then carried to the upper part of the hatch opening by hatch lid 13, which is partitioned by an air-water tight means. After this, as shown in Fig.2, by lifting smaller diameter flange 15b of flexible bellows 15, smaller diameter end flange 15b is connected to disk 4a of fuel replacing cask 4 at the upper part of the hatch opening, by an air-water tight means. After the connection has been made, sliding hatch lid 13 of sliding hatch cover 12 is opened. Using land crane 3, fuel replacing cask 4 is suspended down onto rotation

blocking table 10 which is installed on the top of reactor container 8 (Fig.3). Due to the flexibility of bellows 15, bellows 15 inverts during the suspension of fuel replacing cask 4 over rotation blocking table 10. Because of the flexibility of bellows 15, fuel replacing cask 4 can be suspended down to a location that is eccentric from the center of rotation blocking table 10. The transfer-out operation for fuel replacing cask 4 is performed at reverse steps of those of the transfer-in operation.

As described above, at any processes for transferring fuel replacing cask 4, the hatch opening is closed by either flexible bellows 15 or sliding hatch cover 12. For this reason, the air-water tight partition of reactor chamber 6 is continuously maintained. In addition to this advantage, by adopting flexible bellows 15, a significant reduction in the scales of and a further simplification of the air-water tight partitioning device and the transfer facility are achieved. Moreover, the leaking of radioactive substance containing air to the outside of reactor chamber 6 is significantly reduced.

In the embodiment, larger diameter end flange 15a of flexible bellows 15 is attached to sliding hatch cover 12, and smaller diameter end flange 15b is attached to fuel replacing cask 4 so as to be attachable and detachable as needed. However, by attaching smaller diameter end flange 15b to fuel replacing cask 4 in advance, larger diameter end flange 15a can be attached to sliding hatch cover 12 so as to be attachable and detachable as needed. A reactor building cask such as a reactor core tank cask can be also used as well as fuel replacing cask 4.

[Advantageous Result of the Invention]

According to the invention, the following significant effects are demonstrated:

(1) Because the flexible bellows are adopted as an air-water tight partition, the conventional large scale deck working building is replaceable with a small scale simple deck working building endowed with a wind-rain tight function;

(2) Because the casks are able to be transferred with the land crane alone, a large ceiling crane inside the deck working building is not required;

(3)Because of the compactness and the simplified structure of the deck working building and because no ceiling crane is required, deck facilities are easily installed and removed. The installation and removal periods are also extremely reduced;

(4) Due to no requirement for the ceiling crane and the use of the land crane alone, it is not necessary to perform a replacing work for casks at a larger weight;

(5) The leaking of radioactive substance containing air to the outside of the reactor chamber is controlled as much as possible;

(6) Because the deck working building and the reactor chamber are normally partitioned by an air-water tight means, the inside of the deck working building becomes an advantageous environment for the workers.

4. Brief Description of the Invention

Fig.1 is a schematic diagram illustrating an example of the transfer facility of the invention, which provides an air-water tight partitioning device. Fig.2 and Fig.3 illustrate a transfer work by the facility. Fig.4 is a schematic diagram illustrating prior art transfer facility. Fig.5 is a cross-sectional top view illustrating the facility.

In the drawings, reference number 1 refers to a dock; 2 to a nuclear ship; 3 to a land

crane; 4 to a fuel replacing cask; 6 to a reactor chamber; 7 to a storage container; 8 to a reactor container; 12 to a sliding hatch cover; 13 to a sliding hatch lid; 14 to an inflating seal; 15 to flexible bellows; 15a to a large diameter end flange; 15b to a smaller diameter end flange; 16 to a support cylinder; 17 to a holding arm.

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㊿発明の名称 船用原子炉の燃料交換用キャスク類の搬出入設備における気水密仕切装置

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明　細　書

1．発明の名称

船用原子炉の燃料交換用キャスク類の搬出入設備における気水密仕切装置

2．特許請求の範囲

原子炉室頂部の開口を開閉する気水密性を有するスライド式ハッチカバーと、スライド式ハッチカバーの上記開口の周囲に大径端が気水密に取り付けられ且つ小径端がキャスク類に気水密に取り付けられると共に反転可能に形成された截頭円錐状のフレキシブルベローズとを備えたことを特徴とする船用原子炉の燃料交換用キャスク類の搬出入設備における気水密仕切装置。

3．発明の詳細な説明

［産業上の利用分野］

本発明は船用原子炉を収容した格納容器内に燃料交換用キャスク類を搬出入する際の気水密性を保つためにフレキシブルベローズを採用した船用原子炉のキャスク類の搬出入設備における気水密仕切装置に関する。

［従来の技術］

従来、原子力船の燃料交換設備には第4図、第5図に示すものが提案されている。この燃料交換設備は、乾ドックa内の原子力船bの甲板c上に仮設される船上作業建屋dと、船上作業建屋dの側壁開口を気水密に開閉する滑動扉eと、船上作業建屋d内のキャスク類fを搬送する天井クレーンgと、原子炉室hの頂部開口を気水密に開閉するスライド式ハッチカバーiと、ドックサイドに設けられた陸上クレーンjとから主に構成されている。なお、kは格納容器、ℓは原子炉容器である。

キャスク類fを格納容器k内に搬入する手順を説明すると、まず、船上作業建屋dの滑動扉eを開き、陸上クレーンjによりキャスク類fを船上作業建屋d内に搬入し、キャスク類fをいったん甲板c上に仮置きする。次いで、滑動扉eを閉めて船上作業建屋dの側壁開口を気水密に閉鎖した後、スライド式ハッチカバーiを開いて原子炉室hの頂部開口を開放し、甲板c上のキャスク類f

を天井クレーンgにより格納容器k内に搬入し原子炉容器ℓ上に吊り降ろす。キャスク類fの搬出は上記の搬入とは逆の手順になる。この燃料交換設備では、上述のようにしてキャスク類fの搬出入のどの過程においても可動扉oまたはスライド式ハッチカバーiのいずれかが閉じられているので、照射済み燃料等と環境との間の気水密性仕切を継続して維持することができる。

【発明が解決しようとする問題点】

ところが、上記燃料交換設備にあっては次のような問題がある。

(1) この燃料交換設備では、キャスク類fの運搬手段として陸上クレーンjのほかに船上作業建屋d内に大型の天井クレーンgが必要になる。更に、これに伴なって、気密性を要求される船上作業建屋dと可動扉oが大規模化する。また、このような大規模な船上設備を必要とするシステムでは、その仮設・撤去に時間がかかる上、経済的にも不利であり、実用的でない。

(2) 原子炉室hの頂部のハッチカバーiを開いたときに、原子炉室hから船上作業建屋d内に放射性物質を含む空気が流入するので、環境への放射性物質の流出量が多くなると共に、船上作業建屋d内はその作業従事者にとって不利な環境となる。

【発明の目的】

本発明は以上の従来技術の問題点を有効に解消すべく創案されたものであり、本発明の目的は、舶用原子炉のキャスク類の搬出入設備の大幅な小型・簡素化が図れると共に、放射性物質を含む空気の環境への流出を低減できる舶用原子炉の燃料交換用キャスク類の搬出入設備における気水密仕切装置を提供することにある。

【発明の概要】

上記の目的を達成するために、本発明は、原子炉室頂部の開口を開閉する気水密性を有するスライド式ハッチカバーと、スライド式ハッチカバーの上記開口の周囲に大径端が気水密に取り付けられ且つ小径端がキャスク類に気水密に取り付けられると共に反転可能に形成された截頭円錐状のフレキシブルベローズとを備えてなるものである。

原子炉室は、キャスク類の搬出入作業の全期間にわたって、スライド式ハッチカバーまたはフレキシブルベローズの少なくとも一方により気水密に仕切られる。

【実施例】

以下に本発明の実施例を添付図面に従って詳述する。本実施例ではキャスク類として燃料交換キャスクを挙げて説明する。

第１図は本発明の気水密仕切装置を備えたキャスク類の搬出入設備を示す。同図に示すように、乾ドック１内には原子力船２が据え付けられ、そのドックサイドには陸上クレーン３が設けられている。また陸上には図示省略するが燃料取扱建屋が建てられており、燃料交換キャスク４をこの燃料取扱建屋と乾ドック１との間を運ぶために搬出入用台車５が用いられる。

原子力船２の原子炉室６内には、第１図ないし第３図に示すように、格納容器７が設けられ、格納容器７内には原子炉容器８が収容されている。原子炉容器８の炉心部には核燃料９が設置されると共に、原子炉容器８の頂部には回転遮蔽台１０が設置されている。また原子炉室６頂部のハッチコーミング１１にはスライド式ハッチカバー１２が気水密に取り付けられている。スライド式ハッチカバー１２はハッチ口を開閉するスライドハッチ蓋１３を有し、スライドハッチ蓋１３にはその開閉作動系（図示せず）が連結されている。スライドハッチ蓋１３の気水密性は、スライド式ハッチカバー１２の開口を囲む内周壁部に設けられた環状のインフレートシール１４により保持される。

スライド式ハッチカバー１２上のハッチ口周囲に截頭円錐形のフレキシブルベローズ１５の大径端フランジ１５aが気水密に取り付けられている。更に、フレキシブルベローズ１５の小径端フランジ１５bは、燃料交換キャスク４の外周壁面より延出形成された円環状のディスク４aに気水密に且つ着脱自在に取り付けられるようになっている。また、フレキシブルベローズ１５は截頭円錐形でフレキシビリティがあるため、その小径端を軸方

向に移動することにより反転できるようになっている。また、スライド式ハッチカバー12上にはフレキシブルベローズ15を支持するための支持筒16が立設されている。支持筒16にはサスペンション型の保持アーム17が設けられている。保持アーム17はフレキシブルベローズ15の小径端部を支持するもので、燃料交換キャスク4のディスク4aと小径端フランジ15bとを着脱する際に燃料交換キャスク4が上下動しても燃料交換キャスク4の全荷重がスライド式ハッチカバー12に伝わらないようにしている。

次に、燃料交換キャスク4の格納容器7内への搬入作業を説明する。

ドックサイドの搬出入用台車5上の装荷済みの燃料交換キャスク4は、陸上クレーン3により原子力船2側へ搬送され、そしてスライドハッチ蓋13により気水密に仕切られたハッチ口の上方に運ばれる。次いで、第2図に示すように、フレキシブルベローズ15の小径端フランジ15bを持ち上げて、ハッチ口上方の燃料交換キャスク4のディスク4aに小径端フランジ15bを気水密に結合する。結合後、スライド式ハッチカバー12のスライドハッチ蓋13を開放し、陸上クレーン3により燃料交換キャスク4を原子炉容器8の頂部に設置した回転遮蔽台10上に吊り降ろす(第3図)。フレキシブルベローズ15は截頭円錐形でフレキシビリティがあるので燃料交換キャスク4を回転遮蔽台10に吊り降ろす途中で反転を起す。フレキシブルベローズ15はフレキシビリティを有するので、燃料交換キャスク4を回転遮蔽台10の中心より偏心した位置に吊り降ろすことができる。また燃料交換キャスク4の搬出は上述の搬入とは逆の手順で行なわれる。

このように、燃料交換キャスク4の搬出入のどの過程においてもフレキシブルベローズ15またはスライド式ハッチカバー12のいずれかによりハッチ口が閉じられるので、原子炉室6の気水密仕切を継続して維持できる。また、フレキシブルベローズ15を採用することにより、従来の船上作業建屋による気水密仕切に比べて、気水密仕切装置ならびに搬出入設備の大幅な小規模化・簡素化が図れる。更に、放射性物質を含む空気の原子炉室6外への流出を大幅に低減することができる。

なお、上記実施例では、フレキシブルベローズ15の大径端フランジ15aはスライド式ハッチカバー12に取り付けられ、小径端フランジ15bは燃料交換キャスク4に着脱自在に取り付けられるようになっていたが、小径端フランジ15bを燃料交換キャスク4に取り付けておき、大径端フランジ15aをスライド式ハッチカバー12に着脱自在に取り付けるようにしてもよい。また、キャスク類は燃料交換キャスク4に限らず、炉心槽キャスクなど炉内構造物キャスクなどでも勿論よい。

〔発明の効果〕

以上述するに本発明によれば次のような優れた効果を発揮する。

(1) 気水密仕切としてフレキシブルベローズを採用したので従来の大規模な気水密性の船上作業建屋を、小規模で構造簡単な風雨密性の船上作業建屋とすることができる。

(2) 陸上クレーンのみでキャスク類の搬出入ができ、船上作業建屋内の大型の天井クレーンが不要となる。

(3) 船上作業建屋を小規模で簡素なものとすることができ、また天井クレーン等を不要とすることができることから、船上設備の仮設・撤去作業が簡単にできると共にその期間を大幅に短縮できる。

(4) 天井クレーンが不要で陸上クレーンのみでキャスク類を搬送でき、重量の大きなキャスク類の吊り換え作業が不要となる。

(5) 放射性物質を含む空気が原子炉室外へ流出するのを極力抑えることができる。

(6) 船上作業建屋と原子炉室とは常時、気水密に仕切られているので、船上作業建屋内は作業従事者にとって有利な環境となる。

4. 図面の簡単な説明

第1図は本発明に係る気水密仕切装置を備えた搬出入設備の一例を示す全体構成図、第2図、

第３図は同設備による搬出入作業を説明するための図、第４図は従来の搬出入設備を示す全体構成図、第５図は同設備の平面断面図である。

図中、１は乾ドック、２は原子力船、３は陸上クレーン、４は燃料交換キャスク、６は原子炉室、７は格納容器、８は原子炉容器、１２はスライド式ハッチカバー、１３はスライドハッチ蓋、１４はインフレートシール、１５はフレキシブルベローズ、１５aは大径端フランジ、１５bは小径端フランジ、１６は支持筒、１７は保持アームである。

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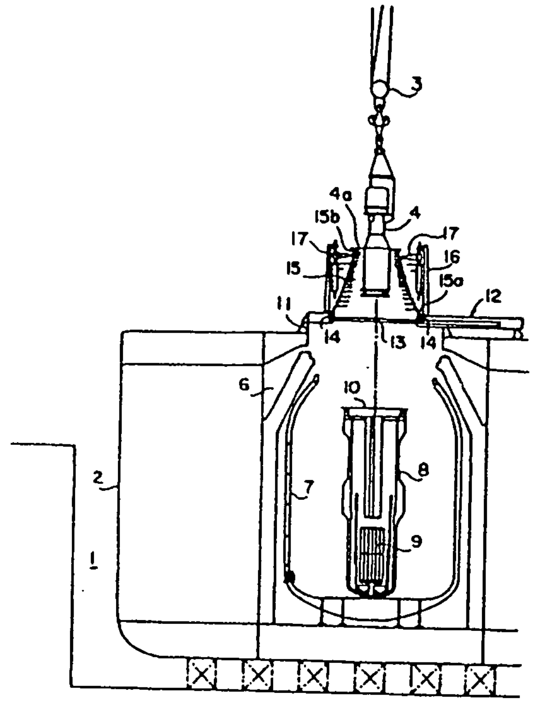
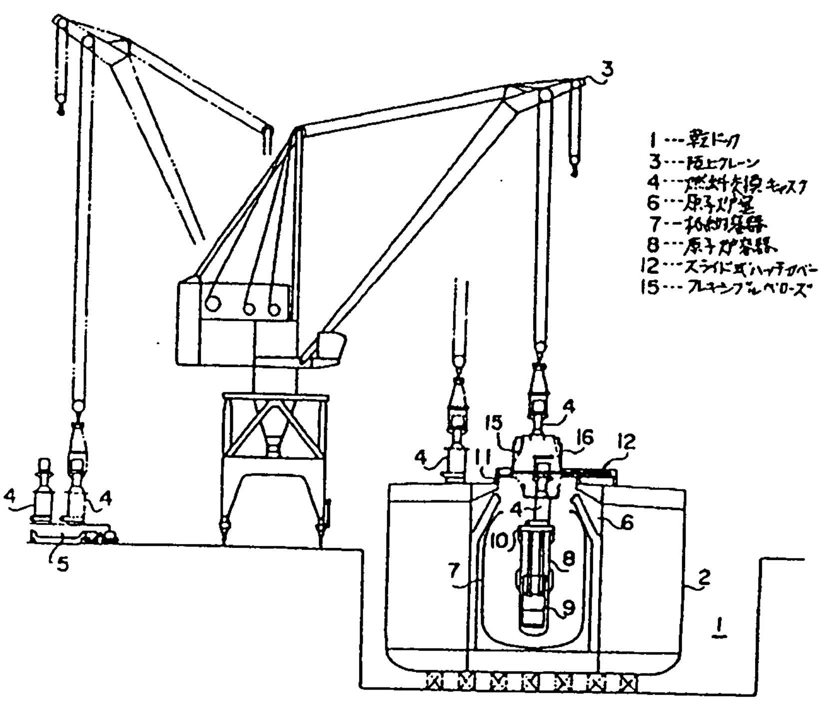
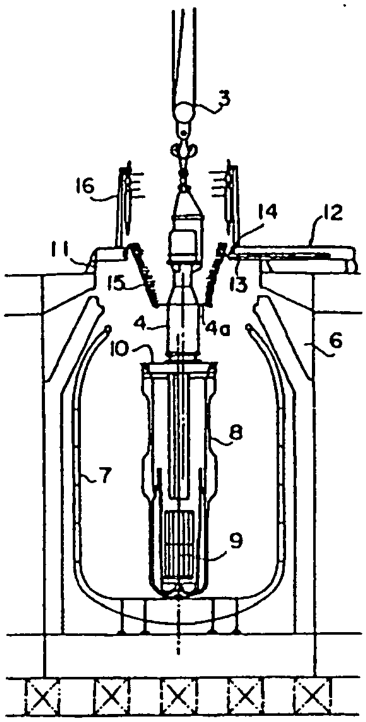


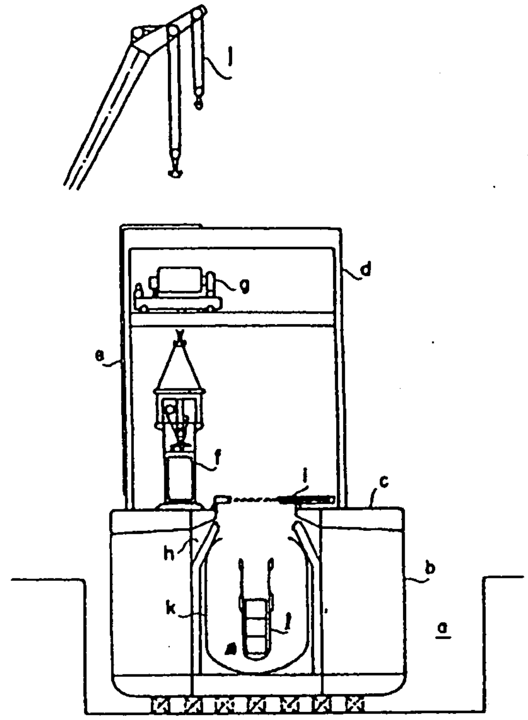
第２図



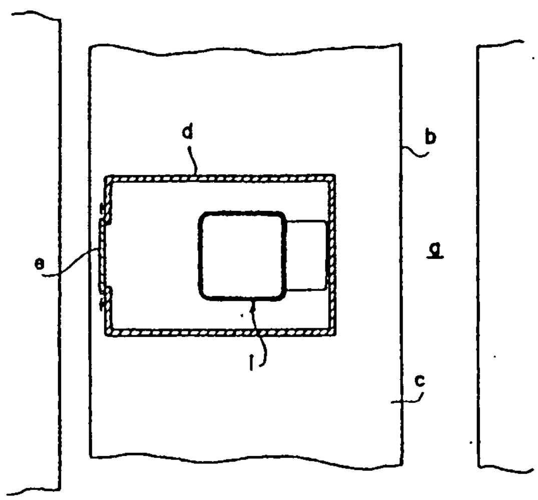
第１図



第３図



第４図



第５図